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(54) Composite woven fabric laminate

(57) A mouldable laminate is made by weaving plies from fabric fibres comprising a proportion of thermoplastic fibres, assembling a plurality of the plies and heating the resultant assembly under pressure, the thermoplastic fibres bonding the plies together and improving the mechanical and other properties of the laminate. The proportion and type of thermoplastic fibre and the number of plies used depends upon the properties required for the intended use of the laminate.

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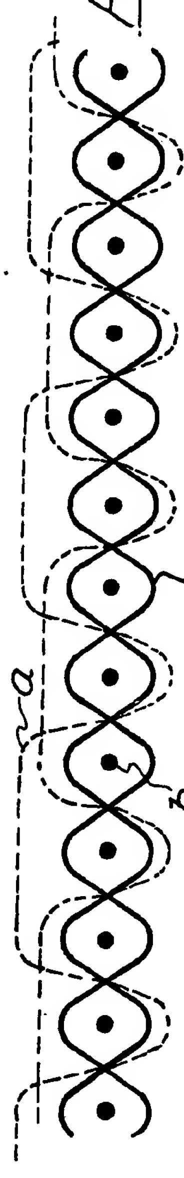

FIG.1

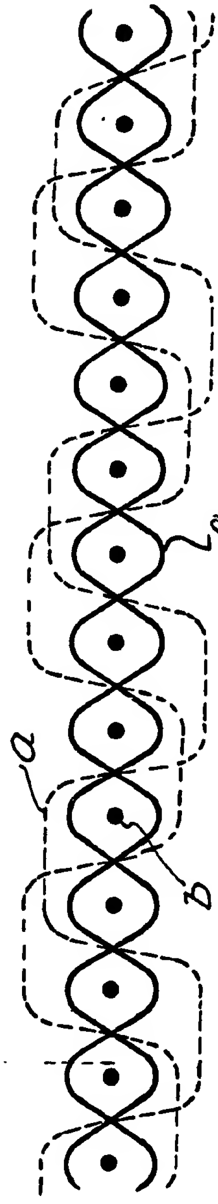

FIG.2

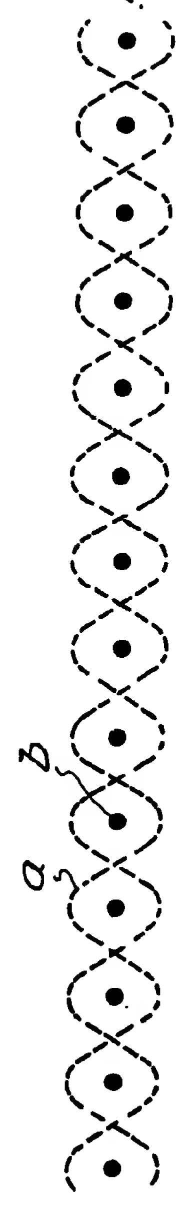

FIG.3

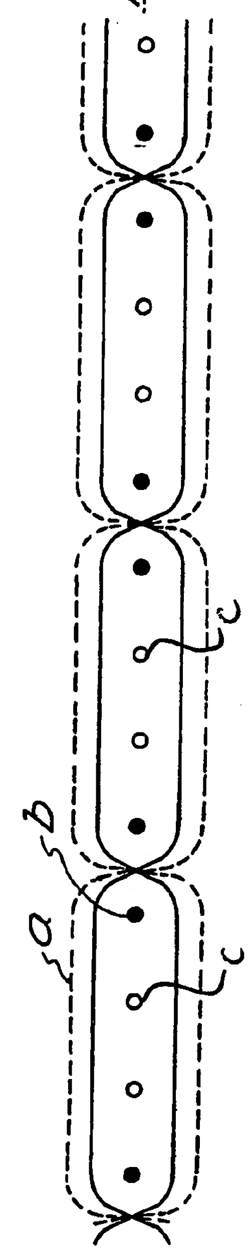

FIG.4

SPECIFICATION
Woven laminates

This invention relates to an improved method for the production of woven laminates and laminates produced thereby and more particularly to the production of woven reinforced thermoplastic laminates either in the form of flat panels or curved pieces.

According to the invention, the method comprises weaving fabric plies from Carbon Aramid or Glass fibres hereinafter referred to as reinforcing fibres together with polyolefine, polyester, polyamide, polyether sulphone and polyether ether ketone fibres or other thermoplastic fibres, hereinafter defined as thermoplastic fibres, assembling a plurality of the plies to form a laminate, heating the laminate under pressure to produce a mouldable laminate, the number of plies of fabric used depending upon the performance requirement of the end use, the thermoplastic fibres serving to bond the plies together and improve the mechanical and other properties of the laminate.

The invention will be described with reference to the accompanying drawings:—

Fig. 1 shows a weave having 75% of the warp *a* and weft *b* of a thermoplastic fibres such as Polythene on one side and 25% on the opposite side and employing aramid warp *a* and wefts *b*.

Fig. 2 shows a weave in which the thermoplastic warp fibres are equally distributed on both sides with aramid weft yarn.

Fig. 3 shows a uni-directional fabric with thermoplastic and aramid warp yarns and aramid weft yarns.

Fig. 4 shows a satin weave allowing greater permeability and draftability than a plain weave and having thermoplastic and aramid warp yarns and reinforcing or thermoplastic weft yarns *b*.

A commonly used aramid fabric for plastics reinforcement is a plain weave fabric with 67 threads per 100mm in both warp and weft directions, consisting of 158 Tex Aramid fibre and thermoplastic warp yarns *a* (Fig. 1).

For the production of a 25mm thick laminate consisting of 15% by weight Polythene and 85% by weight aramid (or carbon or glass) reinforcing fibre, the procedure is the following:—

For the sake of economy it is convenient to introduce the polythene as warp *a*, thread for thread, with the aramid warp and weft fibre.

The linear density of the polythene warp and weft is therefore 30% that of the aramid since the weights of aramid in the warp *a* and weft *b* of the base fabric are equal. Such a yarn is a 0.25mm high density polythene monofilament and may be introduced into the fabric thus, although there are many possible weave variations.

To produce a 25mm thick laminate from the fabric of Fig. 2, 85 plies are placed one on top of the other and placed in a press with pressing plattens heated to 150°C or to a higher temperature when dealing with other material. When the polythene has melted, a pressure of approximately 1MPa (150 psi) will consolidate the laminate to 25mm thickness or alternatively stops at 25mm spacing can be used in the press. After pressing the laminate is cooled, either in or out of the press.

The choice of fibre and thermoplastic matrix and pressing conditions depends upon the end use for which the laminate is intended, as does the ratio of fibre to matrix.

Carbon, Aramid or Glass fibres are of high strength and high modulus.

Similarly the matrices are Polyolefines, Polyester, Polyamides, Polyether sulphone and Polyether ether ketone.

Other fibres and matrices may however be used.

Laminates as described may be made by interleaving woven fabric and the thermoplastic matrix in film or particle form and subsequently heating the assembly under pressure.

The disadvantages of this method are that the thermoplastic films or particles are difficult to handle and can be difficult to manufacture. In laminates where a discontinuous layer of thermoplastic material is desirable the manufacture becomes very complex.

The thermoplastic materials in question however are readily available in the form of textile fibres.

This invention describes the weaving of a single fabric which incorporates both the reinforcing fibre and the thermoplastic matrix in fibre form.

In designing such a fabric there are a multitude of base fabrics which may be selected according to the end use intended. The choice of reinforcing fabric is according to the mechanical, heat resistance, chemical resistance, electrical and other such properties required in the final product. Similar considerations are involved in the selection of the type, quantity and distribution of the thermoplastic fibre. When these parameters have been established the two are brought together to provide a fabric which is essentially the reinforcing fabric with extra threads consisting of the matrix material in filament form.

These extra thermoplastic yarns may be either warp or weft or both. Plies of single fabric are then heated under pressure to melt the thermoplastic filaments which, upon cooling, bond the reinforcing fabric layers together.

It is also possible to make a fabric where the warp consists entirely of reinforcing fibres and the weft entirely of thermoplastic fibres or vice-versa. Plies of such a fabric when placed one on top of another, in the same orientation, will produce a uni-directional laminate which has all the reinforcing fibres in one direction only. Such a fabric can also be used in multi-directional laminates by orientating the reinforcing fibres as required during the laminate preparation.

The advantage of these weaves is that it is possible to manufacture laminates without crimp in the reinforcing fibres.

A further advantage is that the production of curved laminates is facilitated. Simple curvatures

may be made by forming them from a flat laminate before the thermoplastic material solidifies. More complete curvatures can be made by selecting a fabric weave such as satin (Fig. 4) capable of draping round a curved mould prior to pressing.

A further advantage claimed in that high reinforcing fibre content laminates are easily and economically produced and it is possible by using normal textile machinery to melt the thermoplastic filament either partially or completely. This has the effect that the thermoplastic material is not only interwoven with the reinforcing fabric but also bonded thereto.

This can be an advantage in the preparing of the laminate lay up before moulding in that it reduces the risk of fraying of reinforcing fabric during the tailoring operation. Similarly, if cutting methods by ultrasonic or laser techniques, which produce heat, are used, the thermoplastic threads which are cut tend to fuse and again seal the edges.

CLAIMS

1. A method for the production of woven composite laminate fibres, comprising weaving fabrics of reinforcing yarn as hereinbefore defined, and thermoplastic yarn, as hereinbefore defined, assembling a plurality of plies one above the other to form the composite laminate, heating the composite laminated under pressure to produce the mouldable composite laminate, the number of laminates used in the composite laminate depending upon the performance requirements of the end use, the plies and thermoplastic yarn serving to bond the plies of reinforcing yarn together to improve the mechanical and other properties of the composite laminate.

2. A method for the production of composite laminates as in Claim 1, in which the reinforcing yarn and thermoplastic yarn are employed as warp yarns and/or weft yarns.

3. A method for the production of woven laminates substantially as hereinbefore described.

4. A woven reinforced laminate when produced by the method of Claim 1, substantially as described with reference to the accompanying drawings.

5. A composite laminate when produced by the method of Claims 1, or 2 substantially as described with reference to the accompanying drawings.

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